

DOE Office of Petroleum Reserves – Strategic Unconventional Fuels

Fact Sheet: Oil Shale Water Resources

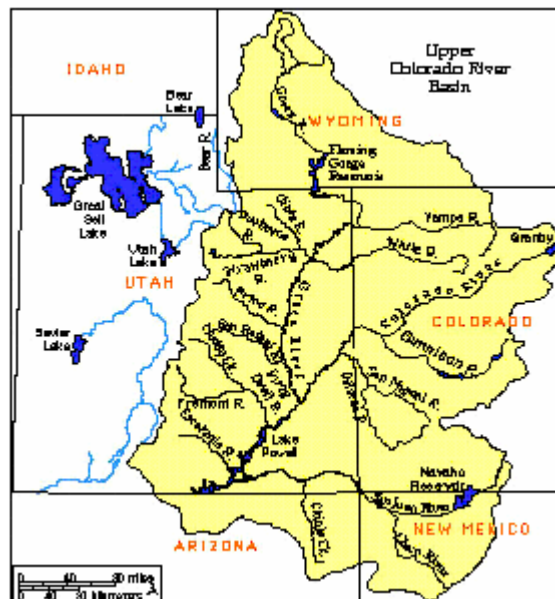
What Water Resources Will Be Needed for Oil Shale Industry Development?

- Development of Western oil shale resources will require significant quantities of water for mine and plant operations, reclamation, supporting infrastructure, and associated economic growth.
- Initial process water requirement estimates of 2.1 to 5 barrels of water per barrel of oil, first developed in the 1970s, have declined. More current estimates based on updated oil shale industry water budgets suggest that requirements for new retorting methods will be 1 to 3 barrels of water per barrel of oil.¹ Some processes may be net producers.
- For an oil shale industry producing 2.5 MMBbl/d, this equates to between 105 and 315 million gallons of water per day (MGD). (See Table 1). These numbers include water requirements for power generation for in-situ heating processes, retorting, refining, reclamation, dust control and on-site worker demands.
- Municipal and other water requirements related to population growth associated with industry development will require an additional 58 million gallons per day.
- A 2.5 MMBbl/d oil shale industry would require 0.18 million to 0.42 million acre feet of water per year, depending on location and processes used.²
- Water supply issues will be less critical for eastern oil shales where water supply is ample.

Where Will the Water Come From?

- In the West, water will be drawn from local and regional sources. The major water source is the Colorado River Basin, including the Colorado, Green, and White Rivers (Fig. 1)³. The Colorado flows between 10 and 22 million acre feet/yr.
- Water may also be purchased from other existing reservoirs. Transfers may be possible from other water basins, including the Upper Missouri.
- Western oil shale has high water content. Some oil shale contains 30-40 gallons per ton of shale. More typically it holds 2-5 gallons of water per ton. Much of this water can be recovered during processing and used to support operations. Produced water will contain organic and in-organic substances that can be removed with conventional filtering technologies.

Figure 1. Upper Colorado River Basin Water Resources¹



- Recycling and re-use of process water will help to reduce water requirements.

How are Water Rights Allocated?

- Water in the West is treated much the same as other commodities – it can be bought and sold in a competitive market.
- Interstate “compacts” control the amount of river water each state is entitled to use. They allocate 5.3 to 5.9 million acre feet to the states. States are expected too use about 4.8 million acre feet of their allocations by 2020. If all industry water were withdrawn from the river, oil shale development would increase withdrawals by 0.18 to 0.42 million acre feet / year. Use of connate water and water re-use could reduce this volume.
- A system of rights and seniority has been established that allocates expected resources. Many private companies previously engaged in oil shale development retain very senior rights they obtained during the 1970s. Because Federal lands and prospective future leases will not come with water rights, some lessees may need to negotiate water purchases to advance projects.

Are Available Water Supplies Adequate to Support a Domestic Oil Shale Industry?

- Initial estimates indicate that enough water will be available to support oil shale industry development in the Western states. However, variability of

Table 1. Estimated Water Demand for Oil Shale Production and Associated Population Growth.

Water Requirement (Bbl Water Used/ Bbl Oil Produced)	Oil Shale Production Rate (Thou Bbls/d)	Oil Shale Industry Water Demand (Mil Gals/d)	Projected Population Growth (People)	Additional Water to Support Population (mil gals/d)	Total New Water Demand (Mil Gals/ d)	Total New Water Demand (Mil acre-ft/yr)
1-3	500	21 to 63	96,000	13	34 to 76	0.04 to 0.09
1-3	1,000	42 to 126	177,000	24	86 to 150	0.10 to 0.17
1-3	2,500	105 to 315	433,000	58	163 to 373	0.18 to 0.42

supply during low flow years may cause conflicts among water users.

- As the industry grows, additional water resources for human consumption and for oil shale processes will likely be required.
- The water consumption growth will slow as oil shale technologies become more efficient.
- For a mature industry, substantial water storage and water transfers may be required over time.

Allocation of Water Rights

The overall allocation of water today is governed by the Colorado River Compact, originally agreed to on November 24, 1922. Currently there is a mix of both absolute and conditional water rights.

- Absolute rights are those that have been decreed by the state Water Court available for use.
- Conditional rights are rights that have not been through the Court process and therefore have not been decreed. They cannot be used until a decree has been granted and the rights have been

determined to be absolute. Conditional rights only preserve a holder's seniority in accordance with the doctrine of first in time, first in right. In addition, conditional rights must undergo a diligence test every six years to preserve the conditional right.

- An absolute right is still subject to being curtailed (a call) in the event the water balance is insufficient for all rights and a senior right holder is being injured.
- To help assure supply, it is customary to file an Augmentation Plan which may consist of a plan for reservoir storage and release or purchase of senior rights that can be provided to a senior right holder.

A recent (October, 2003) agreement between the State of California and the Upper Basin States returns about 0.8 million-acre feet per year to the Upper Basin States that was being over-used by the State of California. This 0.8 million acre-feet/year increment could help support an oil shale industry, if the water were largely allocated to this use.⁴

References

- 1 Cameron, C., M. Hightower, J. Hoffmann and C. Wilson, 2006, Energy Demands on Water Resources, Report to Congress on the Interdependency of Energy and Water, DRAFT, July 2006, Sandia National Laboratories.
- Donnell, J. R. 1991. Oil Shale. Pages 183-188 in H. J. Gluskoter, D. D. Rice, and R. B. Taylor, editors. The Geology of North America, Economic Geology, U.S. Geological Society of America, Boulder, Colorado.
- Office of Technology Assessment (OTA). 1980. An Assessment of Oil Shale Technologies. Washington, D.C.
- Vinegar, H., 2006. Shell's *in-situ* conversion process for oil shale. Oral presentation, 26th Oil Shale Symposium, October 16-20, Colorado School of Mines, Golden, CO.
- 2 Wood, Thomas "Water Resources for Oil Shale" Battelle, 2006.
- 3 www.engineering.usu.edu/uwrl/atlas/ch7/ch7upcolcom.html
- 4 Bunger, J.W., P.M. Crawford, and H. Johnson, "Strategic Significance of America's Oil Shale Resource – Volume II: Oil Shale Resources, Technology and Economics" U.S. department of Energy, Office of Deputy Assistant Secretary for Petroleum Reserves, March 2004.